The Beagle, Records of the Museums and Art Galleries of the Northern Territory, 1995 **12**:53-59

LARVA, PUPA AND NOTES ON GENERAL BIOLOGY OF *TINODES RADONA* NEBOISS (TRICHOPTERA: PSYCHOMYIIDAE).

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ABSTRACT

The larva and pupa of the north Australian psychomyiid caddisfly *Tinodes radona* Neboiss, 1990, are described and figured for the first time. In addition, the larval habitat is illustrated and the pupal habitat is noted and discussed, particularly in relation to the unusual pupal mandibles.

KEYWORDS: Trichoptera, Psychomyiidae, *Tinodes radona*, larva, pupa, habitat.

INTRODUCTION

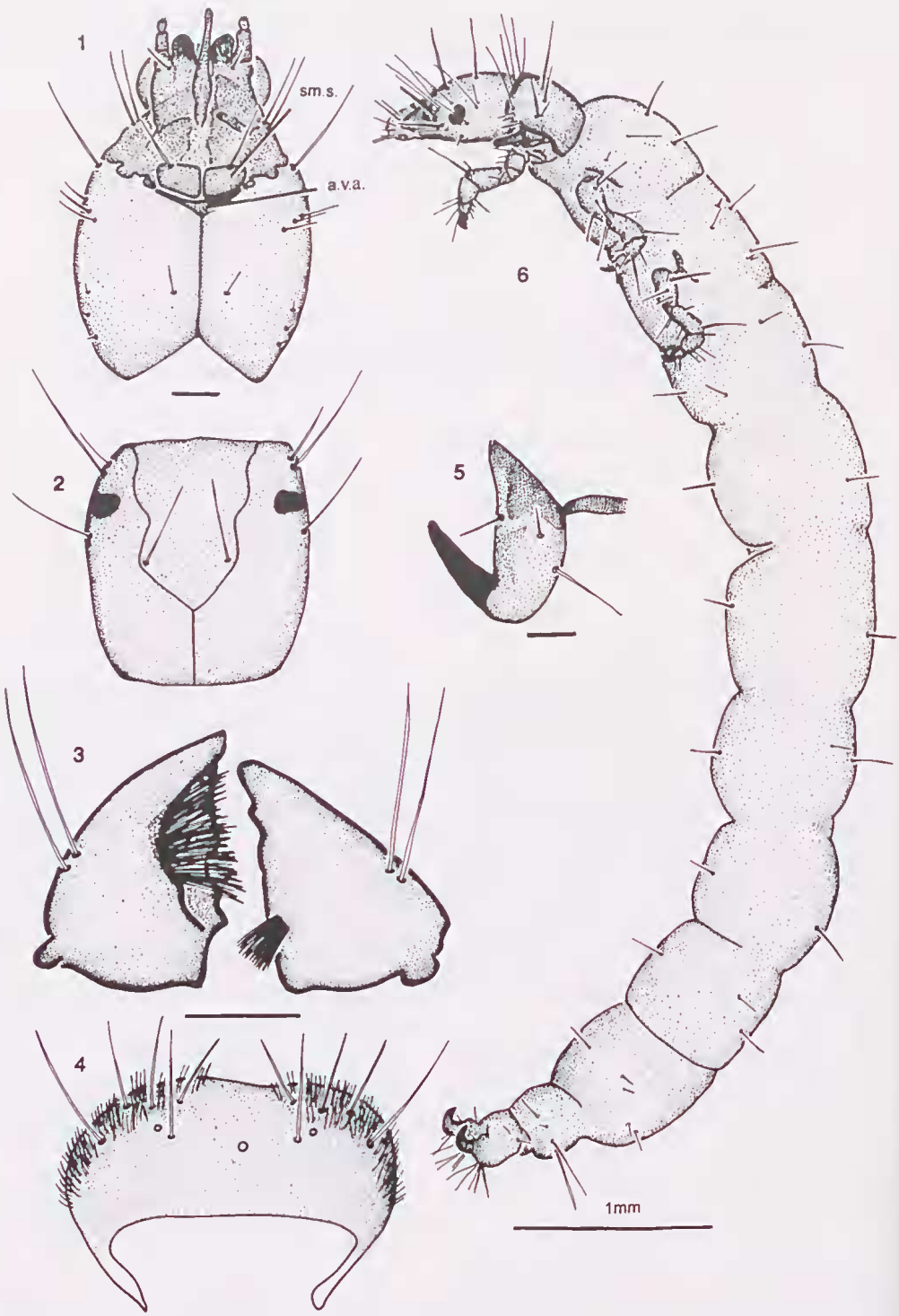
The family Psychomyiidae was reinstated recently on the list of Australian Trichoptera with the description by Neboiss (1990) of two species from northern Australia. Previously, by elevating the subfamily Ecnominae to family status, Neboiss (1977) had removed the record of the family from the Australian fauna. Since the Psychomyiidae *sensu stricto* (excluding the Xiphocentronidae) is widespread in the world, being noted by Wiggins (in 1982, and therefore prior to Neboiss' rediscovery for Australia) as absent only from the Neotropics and Australia, it was not surprising to have representatives of the family found in Australia.

One of the two Australian species, *Tinodes radona* Neboiss, 1990, is based on descriptions of male and female; for the other, *Zelandoptila yuccabina* Neboiss, 1990, only the male is described. Larvae and pupae of *Tinodes radona* are now known. They are similar in aspects of morphology and habits to immatures of some Holarctic species in several genera of the Psychomyiidae and its sister-group, the Xiphocentronidae. However, for completeness of records of the Australian Trichoptera fauna, larval and pupal features and aspects of their general biology are described and illustrated here. As yet, nothing is known of immatures of *Z. yuccabina*.

Neboiss' (1990) work on *T. radona* was based on specimens from the northern part of the Northern Territory, colloquially the "Top End", and from Cape York Peninsula, north Queensland. Additional adults have now been collected from both regions, and in addition, larvae and pupae have been collected from several "Top End" localities.

Adult *Tinodes radona* generally have been taken at lights or in light traps, but several recent Northern Territory collections were made by sweep-netting of vegetation overhanging and bordering waterfalls and cascades. With considerable delight, when collecting in this way on one occasion, I realised that the "chironomid" tubes commonly seen in the splash zone of falls and cascades (Plate 1a) and above water level on boulders (Plate 1b) in streams in the "Top End", are, in fact, the silken retreats of *T. radona* larvae. Larvae of *Tinodes* are reported to feed mainly on detritus and algae (Wiggins 1977) and presumably extend their silken tubes as they graze on the algal material on the rock surface. The finding of larvae, and subsequent searches for pupae, led eventually to the discovery of the sand grain pupal cases on damp rock above water level close to the larval tubes.

The *T. radona* larva and pupa described and figured below were taken from the micro-habitat illustrated in Plate 1b, in Kakadu National Park, Northern Territory. All specimens are in the



Figs 1-6. *Tinodes radona* Neboiss larva: **1,2** head, ventral and dorsal views; **3**, mandibles, dorsal view; **4**, labrum, dorsal view; **5**, anal claw; **6**, habitus, lateral view. Abbreviations: **a.v.a.**, anterior ventral apotome; **sm. s.**, submental sclerite. Scale bars 0.1 mm, unless otherwise indicated.

collection of the Northern Territory Museum of Arts and Sciences, Darwin, together with other specimens collected from the hygropetric zone of a small waterfall in Litchfield National Park, Northern Territory. Slide mounts were prepared for study by macerating specimens in caustic potash, clearing them in clove oil and subsequently mounting them in Canada balsam.

DESCRIPTION

Material examined. 2 larvae, NT, Kakadu National Park, Baroalba Creek, above Koobarra Pools, 4 October 1991, A. Wells; numerous larvae, same locality and collector, 28 June 1992; numerous larvae and pupae, same locality and collector, 12 September 1992; 2 larvae, NT, Litchfield National Park, Aida Creek, 24 June 1992, A. Wells; 1 pupa, Litchfield National Park, Tjaetabe Falls, 4 September 1992, A. Wells and J. Webber.

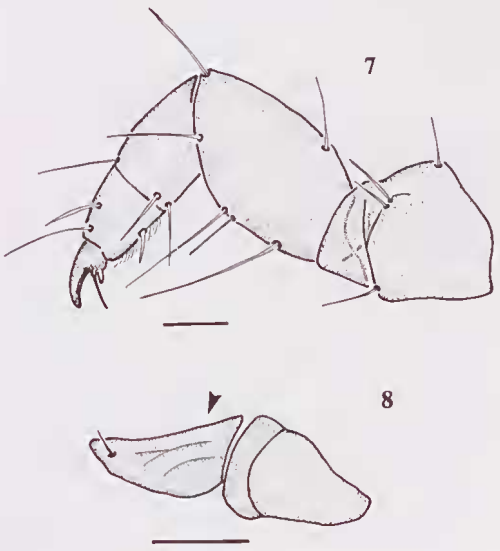
Larva, final instar (Figs 1-8). Body elongate, vermiform; length about 4.6-6.7 mm. Head and thoracic sclerites dark brown. Head in dorsal view (Fig. 2), slightly longer than wide, rounded laterally, truncate anteriorly and posteriorly. Frontoclypeus with anterior margin almost truncate, without setae. Ventrally on head (Fig. 1), a row of setae near anterior and posterior lateral angles, posterior setae very short, one seta beside median suture at about 2/3 length; anterior ventral apotome short, crescentic; posterior ventral apotome absent; paired sub-mental sclerites subquadrate. Labrum (Fig. 4) short, rounded anteriorly, with dense short setae antero-laterally. Mandibles (Fig. 3) short, triangular in dorsal and ventral views, without clear denticles and with pair of elongate setae laterally; left mandible with well-developed penicillus; right mandible with small tuft of setae towards base on inner dorsal margin. Labium forming long slender spinneret (Fig. 1).

Thorax with only pronotum sclerotised, narrow in comparison to meso- and meta-nota. Foretrochantin broad, separated from pro-pleuron by clear suture (Fig. 8). Legs short; forecoxa subquadrate (Fig. 7); tarsal claws rounded. Abdomen without gills. Anal pro-legs short, robust, darkly sclerotised, strongly hooked (Fig. 5). Anal papillae absent.

Pupa (Figs 9-15). Length about 3.0-3.5 mm. Labrum (Fig. 12) with anterior margin entire, broadly rounded, with clustered setae apico-laterally and at baso-lateral margin, short setae mesially. Mandibles (Fig. 13) elongate, length almost 3X basal width, tapered to fine straight section subapically, a small cluster of denticles apically, directed posteriorly; paired lateral setae towards base. Anterior and posterior hookplates on abdominal segment V, anterior hookplates only on segments II-IV and VI-VIII (Fig. 14). Abdomen with short, tapered apical processes (Fig. 15), setae clustered at apices.

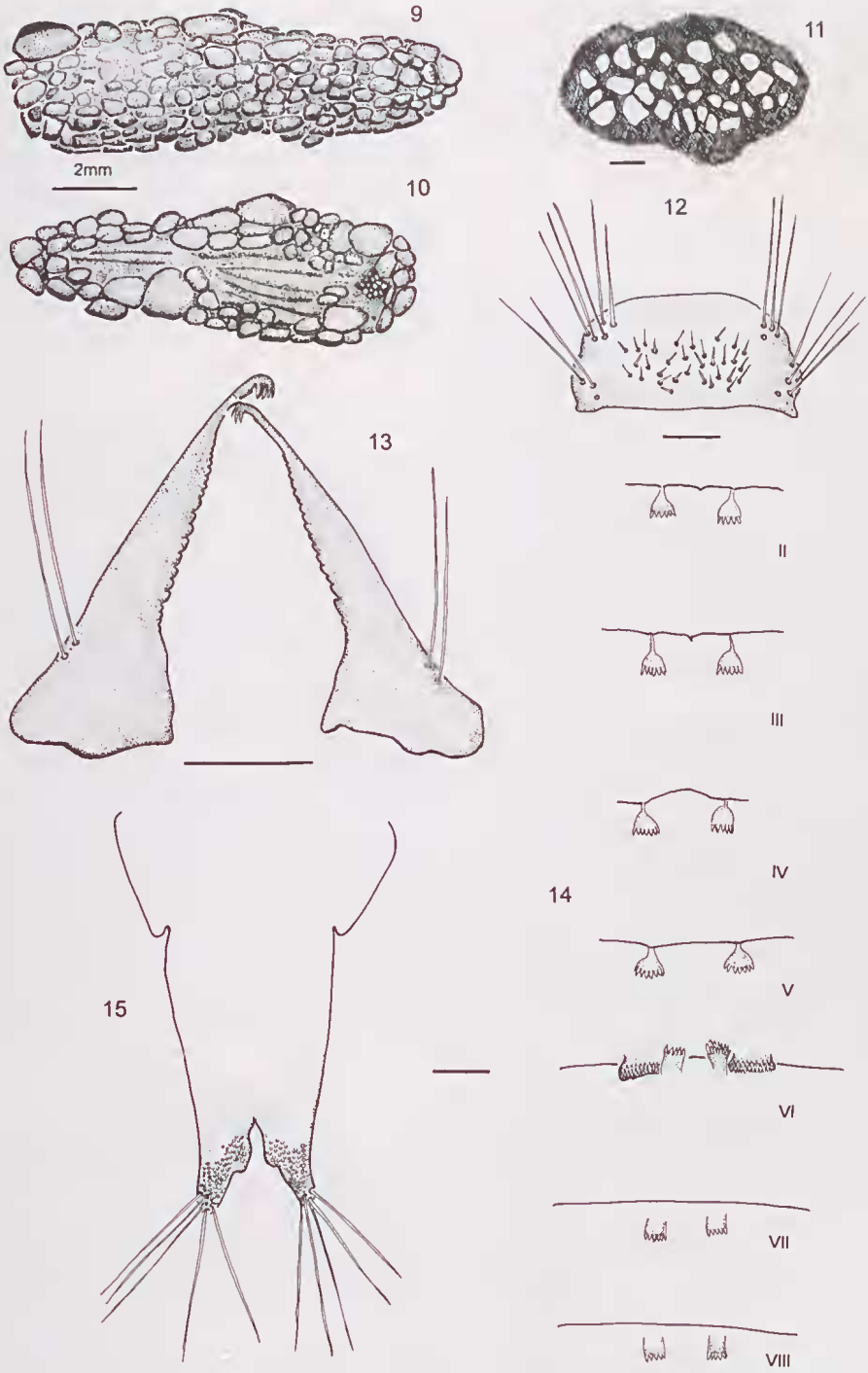
Pupal case (Figs 9, 10), length 4.2-6.5 mm, conical in shape, built of coarse sand grains, flat ventrally over area of contact with substrate, a perforated, more or less ovoid closure membrane (Fig. 11) on ventral surface at broadest (anterior) end.

Habitat (Plate 1a-b). Silken larval tubes up to 30 mm long are found on damp rocks above water at the edges of or in small streams (Plate 1b), and in the splash zone beside waterfalls, cascades (Plate 1a) and riffles, in shaded or open sunny areas. Pupal shelters are constructed on damp rock, above or adjacent to flowing water; the shelters are generally separated by a short distance from the larval tubes. Adults are diurnal and can be seen by day beside flowing water, on rocks and riparian vegetation.



Figs 7, 8. *Tinodes radona* Neboiss larva: **7**, forelimb; **8**, prothoracic pleurites.

Plate 1. Larval tubes of *Tinodes radona* Neboiss: **a**, (top), on rocks in splash zone of a cascade, Oenpelli, Arnhem Land, NT (coin diameter =28 mm); **b**, (below), on a rock in midstream above Koobarra Springs, Kakadu National Park, NT.



Figs 9-11. *Tinodes radona* Neboiss pupal case: **9-10**, dorsal, ventral views; **11**, closure membrane. **Figs 12-15.** *Tinodes radona* Neboiss pupa: **12**, labrum; **13**, mandibles; **14**, hookplates; **15**, terminal abdomen. Scale bars 0.1 mm, unless otherwise indicated.

Remarks. Larvae of *Tinodes radona* are easily distinguished from other Australian species by the combination of membranous meso- and meta-nota and the broad, blade-like foretrochantin. Pupae are recognised by the shape of their mandibles and hookplates.

DISCUSSION

A survey of the literature on the Psychomyiidae reveals that at least one British species of *Tinodes*, *T. assimilis* McLachlan, is found in microhabitats similar to that of *T. radona* (Hickin 1967). Hickin (1967) also mentions that larvae of several other *Tinodes* species are able to withstand removal from free water, either by a drop in water level or when collected for study, for considerable periods of time. In North America (Wiggins 1977), and Europe (Lepneva 1964) the larvae of *Tinodes* appear to live submerged in water, but some larvae in one of the psychomyiid sister group, the Xiphocentronidae, are reported to be hygropetric (i.e. *Xiphocentron*-see Edwards 1961; Flint 1964; Wiggins 1977).

A curious feature of both the Psychomyiidae and Xiphocentronidae is their modified pupal mandibles. These are illustrated for the European *Tinodes rostocki* McLachlan by Lepneva (1964, but her figures are taken from another author), for *Xiphocentron ijaitiensis* (Banks) by Flint (1964), and here for *T. radona* (Fig. 13). Edwards (1961) shows a more extreme version of these mandibles in *X. mexico* Ross, in which the distal parts of the mandibles are whip-like and Hickin (1967) mentions "long scythe-like pupal mandibles" in the psychomyiid *Lype reducta* (Hagen). Members of the Polycentropodidae and Ecnominae have elongate pupal mandibles but without the distal hook. Since other caddis species that build sand pupal shelters have pupae with unmodified mandibles, it is possible that the curiously hooked mandible evolved with the adoption of an unusual niche. Examination of the emergence behaviour of these pupae could be rewarding.

In normal situations, immersed in water, pharate adult caddisflies escaping from their pupal enclosures would be well buoyed up by the surrounding water; pupae removed from their cases into free water often prove hard to "sink", tending to float on the surface of the collecting vessel. However, pharate adults of *T. radona*, when emerging in the hygropetric zone, presumably drag themselves, unaided by buoyancy of water, from their sand grain case, against resistance from the substrate and particularly from its "aufwuchs" covering. The pupal mandibles, which show close resemblance in form to the spagetti scoop of a modern kitchen, probably aid the exit from the case and may also allow the pharate adult to gain some hold in the fine mat on the substrate prior to emergence from the pupal cuticle.

ACKNOWLEDGEMENTS

Specimens were collected in Kakadu National Park with permission from the Australian National Parks and Wildlife Service (now Australian Nature Conservation Agency), and from Litchfield National Park with permission of the Conservation Commission of the Northern Territory. The work was funded by the Northern Territory Museum of Arts and Sciences. Jenni Webber assisted with field work and final preparation of the plates; Ian Morris and Phillip Kempster photographed the larval tubes. Comments by David Cartwright and two referees greatly improved the manuscript. I wish to thank the above mentioned and also staff of the Office of the Supervising Scientist at Jabiru for generous assistance and encouragement with work in the Alligator Rivers region. The manuscript was prepared using facilities provided by the Australian Biological Resources Study and the Division of Entomology, CSIRO, Canberra.

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Accepted 15 February, 1994

The Beagle, Records of the Museums and Art Galleries of the Northern Territory, 1995 12:61-64

LATREUTES ANOPLONYX KEMP, 1914 (CRUSTACEA: DECAPODA: HIPPOLYTIDAE), A JELLY-FISH ASSOCIATE NEW TO THE AUSTRALIAN FAUNA.

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ABSTRACT

This report records the presence of the hippolytid shrimp *Latreutes anoplonyx* Kemp in the Australian fauna, from the Northern Territory and Queensland, and confirms beyond doubt that the species is a genuine associate of scyphozoans.

Keywords: *Latreutes anoplonyx*, Crustacea, Caridea, Hippolytidae, new to Australian fauna, association with Scyphozoa confirmed.

INTRODUCTION

Few caridean shrimps have been reported as associates of scyphozoan coelenterates. One of the first observations of possible association was of the hippolytid shrimp *Latreutes anoplonyx* Kemp, noted by De Man (1929), but the basis of the observation was the discovery of a shrimp "in" a medusa, and not on the study of live shrimps and their host *in vivo*. The present observations appear to be the first of a live hippolytid shrimp in association with jelly-fish hosts.

DESCRIPTION

Latreutes anoplonyx Kemp, 1914

Restricted synonymy

Latreutes anoplonyx Kemp, 1914: 104-105, pl. 4, figs 3-5; - 1916: 369.

Material. 3 females (2 ovig.), Van Diemen Gulf, NT, 36 m, 6 June 1982, FV *Skelton*, NTM Cr.0000191. 22 spms (6 ovig. females), Cameron's Beach, Darwin, NT, 9 March 1978, coll. N.T.Fisheries, NTM Cr.0000191. 28 spms (21 ovig. females), Auckland Creek, Gladstone, Qld., 8 January 1982, coll. P. Saenger, NTM Cr.0002640. 16 spms (no ovig. females), Chambers Bay, Van Diemen Gulf, NT, May 1978, coll. J. Grice, NTM Cr.0007418. 1 male, 1 female, from inner part of Darwin Harbour, about 4.8 km from the wharfs, NT, coll. T. Heeger, 4 June 1993, NTM Cr.010640. 2 males, 2 females, 1 juv., mouth of Buffalo Creek, Darwin Harbour, NT, 12 March 1993, 0.75 m, coll. P.N. Alderslade, P. Horner and N. Smit, NTM Cr.0010531.

Comparative description. The specimens agree well with the descriptions provided by Kemp (1914, 1916) and Liu (1955), but appear to differ slightly from that figured by Hayashi and Miyake (1968b). The adult Darwin Harbour specimens have 12-14 small, acute, dorsal rostral teeth, with 9-10 similar ventral teeth (Fig. 1). The dentate dorsal margin is feebly concave and the ventral margin straight, with the rostral process appearing acute in lateral view. The proximal dorsal rostral tooth is of similar size to the rest of the series, in contrast to the material from the Amakusa Islands, in which it appears distinctly larger than the rest of the series. The rostrum also appears much deeper and less acute, with the distal dorsal border straight and not concave. In the specimens illustrated by Liu, the rostrum also appears much deeper than in the Australian specimens, and in his ovigerous female both dorsal and ventral margins appear distinctly convex. The dactyls of the ambulatory pereiopods are less strongly spinose than those illustrated by De Man (1929). The ventral margin of the corpus bears only two small spinules, instead of four as shown by De Man and described by Hayashi and Miyake (1968a), but also noted with two spinules (Hayashi and Miyake 1968b) for the fourth pereiopod. The unguis is cornified and only feebly distinct from the corpus.

Measurements. The largest adult female specimen from Darwin Harbour has a postorbital carapace length of 13.5 mm and a total body length of

27.0 mm. The largest specimens were from Gladstone, with a postorbital carapace length of 21.9 mm and a total body length of 47.0 mm.

Colouration. The colour pattern of the live shrimps (Fig. 2), not previously reported, closely matches that of the host scyphozoan and is clearly of a cryptic nature. The general colouration is a dull reddish brown. The distal half of the rostrum is a deeper red, with yellow dots proximally; the proximal half colourless. The carapace has a narrow transverse white bar on the anterior cardiac region, curving anteroventrally to fade out on the central branchiostegite. Anteriorly, the carapace is dark red dorsally, with large white spots; posteriorly the carapace is pale red, with scattered darker spots; extending, on to the lower branchiostegite. The abdominal segments are similarly coloured, each having a narrow transverse white bar extending onto the central or lower pleuron, with a narrow, dark red band posteriorly and a broader, paler area anteriorly; the posterior two-thirds of the sixth segment and the caudal fan are colourless. The proximal part of the rostrum, antennule and antenna, and the second to fifth pereiopods are similarly colourless although the meri of the ambulatory pereiopods are feebly spotted with red. The basipodites of the pleopods are similarly speckled with red. The basicerite, third maxilliped and first pereiopod are all reddish. The cornea is pallid. The colour pattern is less conspicuous in the smaller males.

Hosts. *Phyllorhiza punctata* von Lendenfelt, (Mastigiidae), and *Versuriga anadynomene* (Maas), (Versurigidae) [Coelenterata: Scyphozoa]. The associations with *Phyllorhiza* and *Versuriga* represent new host records.

Behavior. The Buffalo Creek shrimps were collected from two specimens of the jelly-fish host obtained by bucket from surface water over 0.75 m depth. The larger jelly-fish had a bell diameter of about 150 mm, and the shrimps were first seen swimming between hosts in the container. The inner Darwin Harbour specimens were collected from a surface swimming specimen of *Versuriga*, over water of uncertain depth. They were observed alive, moving actively around over the subumbrellar surface and rather lethargically over the tentacles.

Distribution. The species was first described by Kemp (1914) from specimens from Bombay, with subsequent specimens from Bombay and from off the coast of Myanmar, at a depth of 13-15m. Further records have been from Indonesia (De Man 1929), Tanjung Krawang, east of Jakarta, Java; (Holthuis 1947), Jakarta and off Panaroekan, eastern Java; China (Liu 1955),

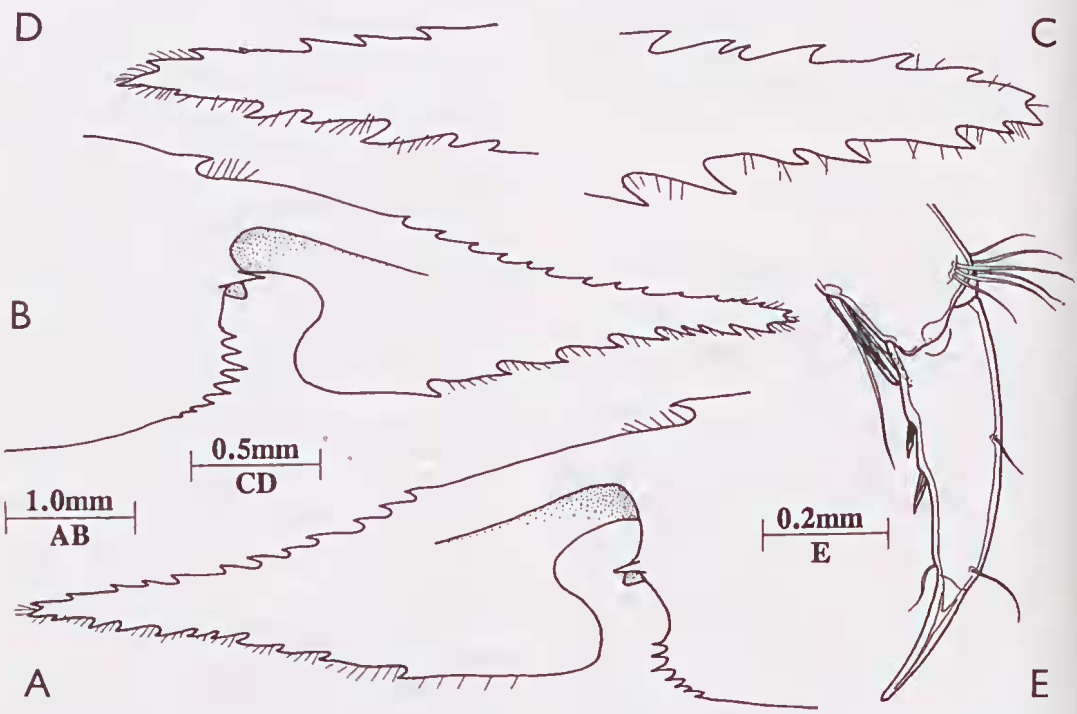

Fig. 1. *Latreutes anoplonyx* Kemp, Buffalo Creek, Darwin. Anterior carapace and rostrum. **A**, male; **B**, smaller female, tip of rostrum; **C**, larger female; **D**, male; **E**, dactyl of third pereiopod, female.

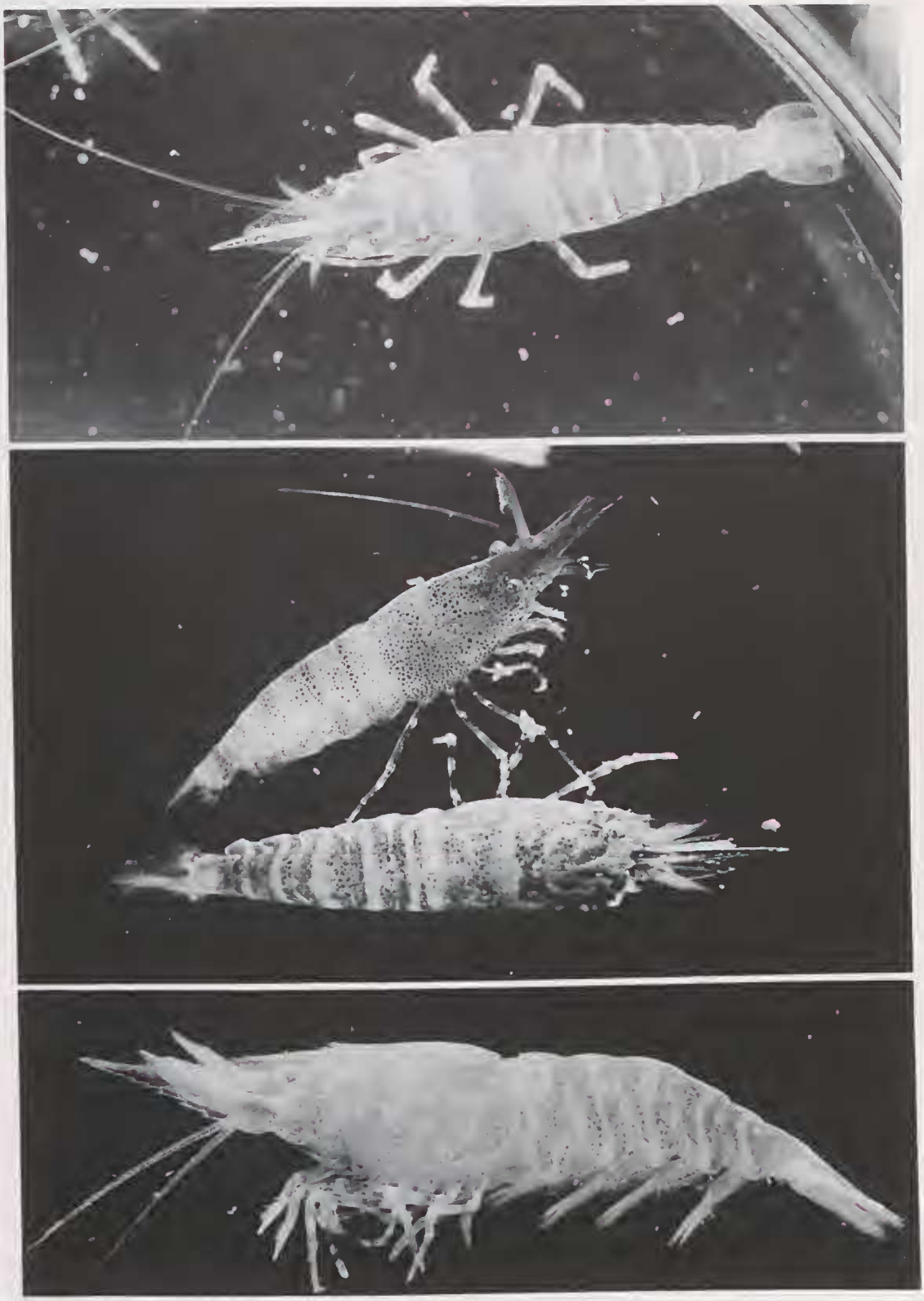

Fig. 2. *Latreutes anoplonyx* Kemp. **A**, female, Buffalo Creek, Darwin; **B**, male and female, Darwin Harbour; **C**, female, Darwin Harbour. Photographs by A. J. Bruce.